MOBILE SATELLITE OPEN SPACE EMPIRICAL DATA MODELING

BEATRICE ANAK NO'EH

Bachelor of Engineering with Honors
(Electronics & Telecommunication Engineering)
2009/2010

UNIVERSITI MALAYSIA SARAWAK

R13a

BORANG PENGESAHAN STATUS TESIS

Judul: **MOBILE SATELLITE OPEN SPACE EMPIRICAL DATA MODELLING**

SESI PENGAJIAN: 2009/2010

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Thesis submitted to the
Faculty of Engineering, Universiti Malaysia Sarawak
to meet the fulfillment of the requirement for
Bachelor of Engineering with Honors (Electronic and Telecommunication) 2010

Dedicated to my beloved parents, sister and brothers.

ACKNOWLEDGEMENT

Firstly, the author is grateful to the Lord Almighty for showing the light and paths to fulfill the dream to complete this final year project thesis. Secondly, the author is deeply indebted to a number of individuals who helped make this thesis possible.

Besides, I deeply appreciate the guideline that I have received from my supervisor Dr.Wan Azlan Wan Zainal Abidin for his skill, patience, valuable advice and encouragement. I would like to take this opportunity to thanks everyone who has contributed either directly or indirectly throughout this project and this thesis.

Finally, I would also like to thank all of my family and my friends for their moral support on me, especially to the master student, Ms Bong, my parents, brother and sister.

ABSTRAK

Satelit bergerak telah menjadi suatu teknologi yang semakin mendapat perhatian dalam dunia komunikasi. Kajian yang dilakukan untuk mendapatkan isyarat ke tahap yang optima telah dijalankan di antara satelit bergerak dan stesen penerima. Di kawasan yang terbuka, walaupun laluan pandangan tidak dihalang ralat masih wujud dalam isyarat. Bagi isyarat dalam jalur L, ralat ini disebabkan oleh laluan yang pelbagai dan kesan ionosfera. Analisa yang dijalankan berdasarkan nisbah di antara isyarat dan bunyi dan sudut ketinggian satelit dari permukaan bumi serta kesan samar. Keputusan daripada analisa menunjukkan kebergantungan nisbah isyarat dan bunyi terhadap sudut ketinggian satellite dari permukaan bumi dan dapat dipersembahkan dalam bentuk model matematik. Model matematik yang dapat menerangkan isyarat ini dengan baik adalah dengan menggunakan fungsi eksponen berdasarkan kriteria fungsi matematik ini yang dapat melalui majoriti data serta nilai dari hasil perhitungan. Kesan samar berlaku apabila isyarat berada di bawah isyarat rujukan, 44 dBHz. Kesan samar ini disebabkan oleh laluan yang pelbagai atau kesan ionosfera berdasarkan sudut ketinggian satelit dari bumi.

ABSTRACT

Mobile satellite has been one of the technologies utilized in today's communication. In order to obtain the signal with greater performance, research has been done on the propagation link between the mobile satellite and receiver. In open space, the line of sight is not obstructed but there is still error in the signal received. For signal in L-band frequency, this is due to the multipath effect and ionospheric effect. Analysis on the signal performance is carried by considering the signal to noise ratio (SNR) and elevation angle as well as the fade effect. Analysis shows the dependency of SNR against elevation angle which it is presented in mathematical model. Mathematical model for SNR against elevation angle is best described by exponential function based on their smooth line through most of the data and their goodness of fit. Fade effect occur when the signal is below the reference signal, 44dBHz. The fade is due to either multipath or ionospheric effet based on the elevation angle limit.

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LIST OF ABBREVIATIONS

LMS	-	land mobile system
MS	-	mobile satellite
NMEA	-	national marine electronics association
SNR	-	signal to noise ratio
GPS	-	global positioning system
LEO	-	low earth orbit
MEO	-	medium earth orbit
HEO	-	high earth orbit
GEO	-	geosynchronous earth orbit
ITU	-	international telecommunication union
DAB	-	digital audio broadcasting
LNBC	-	low-noise block converter
NASA	-	national aeronautics and space administration
ISS	-	international space station
Wi-Fi	-	wireless
DSN	-	deep space network
IEEE	-	institute of electrical and electronics engineer
UHF	-	Ultra High Frequency

MSS	-	Mobile Satellite System
FSS	-	Fixed Satellite System
BSS	-	Broadcasting Satellite System
LMDS	-	Local Multichannel Distribution Service
DBS	-	direct broadcasting service
MMSS	-	maritime mobile satellite service
AMSS	-	aeronautical mobile satellite service
LMSS	-	land mobile satellite system
LOS	-	line of sight
MED	-	modified exponential decay
MHz	-	mega hertz
ERS	-	empirical roadside shadowing
dBHz	-	decibel hertz
GHZ	-	giga hertz
PDF	-	probability density function
CDF	-	cumulative density function
LCR	-	level crossing rate
GRLN	-	generalised rice-log-normal
DLR	-	deutsches zeutrumfiir luff-und raumfahrt
AFD	-	average fade duration
PSD	-	power spectra density
MP	-	multipath part

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

This is a research and analysis on the empirical data resulted from the experiment conducted on mobile satellite signal performance in open space. Mobile satellite (MS) is suitable to cover wide area with mobile users [1]. Besides that, the coverage is also not limited in range when compared to fixed satellite as it moved orbiting the earth. In LMS communications, analysis on multipath fading and ionospheric effect is important in determining the distribution of the received power level. SNR value 44dB is used as the reference signal in order to conduct the analysis for signal performance [2]. Therefore, in order to construct a high capacity mobile satellite communication network, the knowledge of statistical properties of fading and shadowing is necessary. From the analysis result, a mathematical model which describes the dependence of signal quality on elevation angle is developed.

1.2 Statement of Problems

The degradation of MS signal performance is affected by shadowing effect and multipath fading. In order to reduce the cost for measuring the signal performance for

MS, a system with similar characteristic with actual receiver is used. Under open space environment, measurement of MS signal is taken by measuring the incoming signal which comes directly or indirectly. Indirect signal is caused by the different path that the signal propagate through to arrive at the receiver.

Acquisition data from measurement under the open space in Japan and Sarawak, Malaysia will be use throughout this research to be analyzed. The manner of the data can be represented via model. Functions that fitted through most of the data will determine a good model for the data.

The recorded data obtained is in National Marine Electronic Association (NMEA) protocol. Parameters values from the experimental data will be identified which concisely represents the whole data. The desire parameter for the determination of a model is signal-to-noise ratio (SNR), the satellite elevation angle, satellite azimuth angle, satellite id and time.

1.3 Objectives

The main objectives of the project are listed as follows:

a) **To identify the modeling techniques to describe the data**

   Regression method consists of different mathematical function such as polynomial and exponential function. The best model is selected when the curve